THE BRITISH VETERINARY JOURNAL

EDITORS:
T. DALLING, *M.A., M.R.C.V.S.* J. McCUNN, *M.R.C.V.S., L.R.C.P.*

Vol. 106 **June, 1950** **No. 6**

EDITORIAL

POULTRY HEALTH

DURING the war, when the poultry flocks of this country were considerably depleted, there was an apparent reduction in the incidence of some diseases as shown by the results of post-mortem examinations carried out at various laboratories. Such results, however, may not be a true reflection of the position, for, because of the need to conserve food-stuffs, culling was probably heavy and only heavy losses were the subjects of investigation and report. Some "new" diseases were reported to be present in the country during the war, e.g., diseases associated with the presence of members of the Salmonella group of micro-organisms, hitherto unrecognised, "pullet disease," six-day chick disease, etc. Some diseases were apparently related to the types of food in the diet, and some infections were probably introduced into the country. It is interesting to observe that these diseases appear to have become much less prevalent, or even to have disappeared, as feeding stuffs have become more plentiful. Some credit must also, of course, be given to the adoption of methods of control and prevention, brought into practice following the results of research work.

Poultry, as with all livestock, have diseases peculiar to themselves and there must be continuous research to recognise, study and work on problems of poultry health and disease. Some diseases are now well recognised and up-to-date methods of control are available and are being applied. Methods of control must vary according to circumstances and according to the policy of a country. In the case of Newcastle disease, for example, there is no doubt that vaccines are available which give a high degree of protection against natural infection. Vaccination as a control policy is carried out in some countries: in other countries, like the United Kingdom, vaccination is not the control policy, but reliance is placed on the slaughter of infected and contact birds, together with the limitation of movements, prohibition of sales, shows, etc., in certain areas. Research work, however, results in a clearer understanding of control measures and their application.

Animal husbandry, generally, is now recognised as a subject of much importance in the health of livestock: this is especially true of poultry. Bad husbandry is bound to lead to interference with health, and, in the event of the introduction of infection, may mean disaster. There is still much to be investigated concerning poultry husbandry and the best methods to be adopted in poultry keeping. Time is necessary before such investigations can be extended, and more workers are badly needed. As the poultry industry develops further, more attention will have to be given to the subject of poultry husbandry in this country, in order that the best results of poultry keeping may be forthcoming The subject is extensive and embraces many points, each of which may eventually be related to the health and laying capacity of the flock. There is need now for fundamental research on the whole life of poultry: from incubation to rearing and housing: from feeding and nutrition generally to the prevention of some of the less well-known diseases which may assume epizootic characters under certain almost unknown conditions. A case in point is described in an article in this issue of the BRITISH VETERINARY JOURNAL. Our knowledge of the various mycoses of poultry is very imperfect, as well as the conditions under which the causal agents assume a high state of pathogenicity. Close study by specially trained workers is the only means of obtaining the necessary knowledge and of devising preventive measures.

The poultry industry is increasing in size: it is a valuable asset in a country and merits the spending of considerable sums of money on its special research problems. All the indications point to the desire of all concerned that research work on poultry should be increased, and there is little doubt that it will be increased. As in many other branches of science the limiting factor to an immediate increase in the amount of research work is the dearth of trained workers. It may be that in the past there has been a certain amount of disinclination for young men and women to embark upon a career leading to research work in poultry. It may be that other types of livestock have held attractions for them, with the result that poultry work has been neglected. It is now quite obvious that the many problems associated with the health of poultry give promise of interesting and profitable work, and that the need for that work is great. Those who have worked on poultry problems know well that in the hen we have a subject which lends itself to research work from many points of view. No young man or woman, looking for a research career, will find many dull days when working with poultry. The indications are that poultry research is beginning to attract young workers: we hope that the numbers will increase and that many of the outstanding problems will soon be the subject of active research work in this country.

GENERAL ARTICLES

MYCOSIS OF THE CROP (MONILIASIS) IN POULTRY, With Particular Reference to Serious Mortality Occurring in Young Turkeys.

By J. D. BLAXLAND and I. H. FINCHAM,

Ministry of Agriculture and Fisheries, Veterinary Laboratory, Weybridge.

Introduction

A SURVEY of the literature suggests that until a few months ago (Buxton, Darcel, Gordon and Horton-Smith, 1949), mycosis of the upper digestive tract in poultry was not a disease of much importance in Great Britain, although reports between 1932 and 1934 had described outbreaks in America where losses had occurred in poults and chicks.

Gierke (1932), in a preliminary report, described 8-20 per cent mortality in young turkeys, and Jungherr (1933) reported losses totalling 10,000 chicks in a commercial hatchery; the average mortality in a group of chicks was 63 per cent. Jungherr isolated three types of yeast-like fungi from affected chicks: *Monilia albicans, Monilia krusei,* and a species of *Oidium.* Hinshaw (1934), described several outbreaks of disease in turkeys and chicks, in which deaths had occurred with extensive lesions in the crop and upper digestive tract and from which he isolated *M. albicans.* He was careful to stress that it was more common to encounter the disease in association with mismanagement and other debilitating conditions, than as a primary infection.

During July and August, 1949, five outbreaks of this disease were diagnosed in young turkeys, three of them on Accredited Poultry Breeding stations in Norfolk, Suffolk and Sussex, and the other two on smaller rearing establishments in Hampshire and Surrey. The clinical history and post-mortem findings in these outbreaks were similar to those described by Hinshaw and Jungherr, and a yeast-like fungus, *Candida albicans,* was isolated from affected poults.

Although Wilson (1949) referred to the isolation of *C. albicans* from chicks and turkeys in Scotland some 15 years ago, there are no reports in this country of the incidence of yeast-like infections of poultry, and it was therefore decided to initiate a survey of routine post-mortem specimens.

The first part of this paper describes the disease as it occurred on the five turkey farms and gives an account of the diagnostic procedures adopted. The second part is a preliminary report of a survey of routine post-mortem specimens, together with a description of some of the yeasts that were isolated.

History of the Outbreaks in Young Turkeys

The histories of these outbreaks are summarised in Table I (page 223).

It is of considerable interest to note that Farms A and C supplied several thousand day-old poults to their customers during the period that they were themselves experiencing serious losses among poults retained for their own

rearing. The poults which were sold all reared satisfactorily, with the exception of the single group of 50, supplied, when two days old, from the brooder house of Farm C to Farm D; all other customers received poults straight from the incubator. After diagnosis of the disease, poults were reared satisfactorily on Farm C itself, when taken from the incubator to outdoor units, only a few hundred yards away from the brooder house. On this farm there seemed no doubt that the infection was concentrated in the large brooder house, but on the other premises infection appeared to be widespread throughout the individual units and also on the ground.

Symptoms

Affected poults did not usually show any diagnostic symptoms. In addition to poults showing evidence of specific vitamin and mineral deficiencies, such as crusted, scabby lesions on the eye-lids and corners of the mouth and superficial dermatitis with scab formation on the feet, the growth of poults in affected groups was very uneven; feathering was loose and there was general unthriftiness. In older poults, in which the disease was more chronic, there was usually considerable loss of body condition, but when the disease was acute in the younger birds, body weight was normal. On two of the farms, affected poults showed marked nervous symptoms, such as a staggering gait and twitchings of the head, and in one outbreak the dead poults lay with their heads and necks retracted almost into the shape of an "S" and with their legs stretched out backwards, as if they had died in a nervous spasm. Death usually took place about two days after the onset of general malaise and inappetance; there was no evidence of a digestive disorder, and diarrhœa was not a symptom of the disease.

Post-mortem Examination

During the investigation of these outbreaks a large number of individual autopsies was performed. The general appearance of the carcasses of the dead poults varied considerably, according to the adequacy of the diet and standard of management practised on the farm upon which the outbreak was occurring.

In many of the poults on one of the farms there was extensive superficial ulceration and necrosis inside the beak and mouth and on the tongue, but this feature was not noticed in specimens from the other outbreaks. The causal organism was subsequently isolated from these lesions.

The crop was the site of the most characteristic lesion. The lesion in acute cases was a flocculent exudate, greyish-white in colour and loosely adherent to the underlying mucous membrane, rather resembling a small quantity of curdled milk. In the more chronic cases there was thickening of the wall of the crop, the inner lining being covered by a corrugated mass of piled-up yellowish-white necrotic material, a lesion very aptly described in the American reports of the disease as resembling a piece of turkish towelling. In some poults the "towel-like" lesion was distributed in patches over the lining of the crop. In some specimens a mucoid exudate over the crop lining was the only lesion.

TABLE I.

Summary of the history of five outbreaks of Moniliasis.

Farm	Total mortality.	Course of disease.	Rearing methods and management.	Factors possibly associated with the mortality.
A	1,400 died out of 3,900 poults retained for rearing — survivors stunted and development retarded.	Commenced in poults 4-6 weeks old soon after they were allowed access to the ground. Peak mortality about middle of August—only 2 per cent mortality in February and March hatches.	Small battery brooders for 3 weeks — then into outdoor brooder houses holding about 150 poults each. General management and hygiene good.	Typical lesions of dietetic dermatitis observed in some groups, although diet fed did not appear to be deficient in Vitamin B. *Salm. typhi-murium* isolated from individual poults. Mild duodenal coccidiosis.
B	600 died out of 1,000 poults retained for rearing—survivors stunted.	Commenced in poults 4-6 weeks old, —70-80 per cent mortality at 8 weeks in some groups. In each successive group disease commenced earlier—some of the later groups were affected at 10-14 days old. Poults supplied to customers reared normally.	Rearing under hens and in battery brooders. Moved to solid floor houses at 3-4 weeks old. Mortality less in batches reared under hens. General management very poor.	Bad hygiene. Widespread evidence of dietetic dermatitis and perosis in poults of all ages. Many individual cases of aspergillosis.
C	6,000 poults died—only about 1,000 early hatched chicks reared satisfactorily.	Commenced in May and June in poults 10-14 days old, and at this period ceased when they were three weeks old. Peak mortality in July; 80-90 per cent of affected groups died and period of susceptibility extended to poults 5-6 weeks old. Several thousand day-old poults supplied to customers reared normally.	One large brooder house containing small home-made wire floored units. Moved into similar cages outside when about 6 weeks old. General management very poor. Several features in design of brooders encouraged spread of disease.	Bad hygiene. Some evidence of dietetic deficiencies. *Salm. typhi-murium* isolated from individual poults.
D	360 died out of 460 purchased for rearing. Survivors very stunted.	Disease introduced by the purchase of 50 two-day-old poults from Farm C. Spread to other groups which were one, 8 and 10 weeks old; peak mortality middle of July, a month after introduction of infection.	Battery brooder to floor brooder and then to external cages. Hygiene good.	Diet quite unsuitable even under normal circumstances. Evidence of dietetic dermatitis and feather picking. *Salm. typhi-murium* isolated from individual poults.
E	20 died of 38 in one group and 41 out of 43 in another.	Commenced middle of July in poults 4 weeks old.	Wire floored brooders with sun parlours.	No other details obtainable.

The underlying surface, after removal of the exudate of necrotic material, was smooth but inflamed. In a small number of individual poults the lining of the lower œsophagus and entrance to the proventriculus also showed the same necrotic lesions.

The crop and gizzard of the dead poults were usually empty, except for fluid and grit. In the outbreaks in which dietetic errors were evident there was often a quantity of coarse, undigested material in the gizzard, while the intestines were thin-walled, flabby and empty, except for discoloured fluid. In poults from one of the outbreaks there was often catarrhal enteritis, owing to mild duodenal and intestinal coccidiosis.

Histological Examination

Microscopical examination was made of sections through the thickened wall of the crop stained with hæmatoxylin and eosin. The lesion consisted of a proliferation of the *stratum corneum,* the outer layers of which were very ragged and broken, the deeper layers containing the branching hyphæ of the fungus. The hyphæ seldom penetrated into the *rete mucosum.* There was a surprising absence of inflammatory reaction in the invaded tissue, and the number and type of the blood elements present in the small blood vessels in the wall of the crop appeared normal.

Using the Gram Claudius method of staining, it was possible to demonstrate numerous yeast cells in the epithelial debris, but hyphæ predominated in the deeper layers.

There were no macroscopic lesions in any of the other visceral organs and, in most of the batches examined, there were a few poults that did not show the characteristic lesions just described. When these field investigations and examinations were being carried out, it was not appreciated that *Candida albicans* could become a blood-stream infection, nor that intravenous inoculation into rabbits could cause striking lesions in the kidneys. The possibility cannot therefore he excluded that, in some of the poults in which macroscopic lesions could not be detected, the fungus might have spread to other organs, perhaps to the brain, thus accounting for the nervous symptoms occurring in some outbreaks. It was unfortunate that, when specimens were available, histological examination was confined to the crops of the infected turkeys.

Diagnosis

(*a*) Routine bacteriological examinations were always carried out as a preliminary measure to eliminate the possibility of bacterial infections, and in some of the outbreaks, where nervous symptoms were present, it was also necessary to consider the possibility of Newcastle disease. On post-mortem examination, a careful examination of the lining of the crop of all the poults in a group was essential, as the lesion was easily missed in acute cases of the disease.

(*b*) Yeast cells and mycelia were demonstrated in direct smears prepared from scrapings of the crop lesion and examined under the $\frac{1}{6}$″ objective of the microscope. The smears were mounted in lacto-phenol or 10 per cent sodium

hydroxide; it was an advantage to heat the slide slightly to obtain better clearing of the preparation.

(*c*) Cultures of a yeast-like fungus were isolated from the crops, and sometimes from the mouth and tongue, using Sabouraud's agar, dextrose-glycerine agar or malt extract agar plates. After 24 hours' incubation at 37 degrees C., it was difficult, with the naked eye, to distinguish the yeast growth from bacterial contaminants, but microscopical examination of smears of the growth stained by Gram, or by using the Nigrosin method described in the next section, very quickly served to distinguish the budding yeasts from bacteria. Cultures of the yeasts isolated from turkeys in all five outbreaks were confirmed by Dr. G. C. Ainsworth, of University College of the South-West, Exeter, as being *Candida albicans*.

A more detailed description of the organism and of the techniques used is given in Part II of this paper.

Control of the Disease

A reliable treatment for mycosis of the crop is not known. Hinshaw recommended the use of a 1 in 2,000 solution of copper sulphate as the sole source of drinking water; this treatment, however, was tried without success in all five outbreaks of the disease.

Jungherr found that denatured alcohol and coal-tar derivatives were ineffective as disinfectants against this fungus, and he suggested that iodine preparations should be used. On Farm C, it was claimed that the large brooder house, referred to in Table I, had been "thoroughly disinfected" following the initial mortality early in the season, but in view of the general level of management and hygiene on this farm, it was not surprising that the infection persisted. Subsequent contact with the owner of Farm D revealed that a fresh group of poults had been reared successfully, using the same equipment in the same brooder house after disinfection; hot soda water had been used for initial cleaning, followed by a blow lamp on the corners, cracks and crevices of the woodwork, with a final soaking with a strong solution of a coal-tar disinfectant. Judging from the experience of this owner, therefore, it seems possible that infection can be eliminated by efficient disinfection.

The importance of associated debilitating conditions in the causation of this disease cannot be over-emphasised and it follows that the maintenance of a high standard of general management, with particular reference to the prevention of dietetic deficiencies, is essential in controlling outbreaks.

PART II

Subsequent to the diagnosis of the five main outbreaks of moniliasis described in Part I, an attempt was made to assess the incidence and significance of *Candida albicans* in the crops of turkeys and fowls submitted for routine post-mortem examination. It was found that crop lesions visible to the naked eye occurred more commonly than had previously been supposed, although they were seldom present unless accompanied by some other debilitating condition. Cultural and microscopical examinations were carried out on material from the

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crops of birds showing visible lesions and also on scrapings from crops which appeared normal to the naked eye.

Results of the Survey

Fifty-five turkeys were examined; 28 showed macroscopic lesions of mycosis in the crop. *Candida albicans* was isolated from 14 of the turkeys, but only eight of them had shown lesions of mycosis. In only two of the fourteen was mycosis actually diagnosed; seven had died of blackhead, and the remaining five were classified as "general debility" or "undiagnosed." Yeast cultures, which did not show the characteristics of *C. albicans,* were isolated from a further six turkeys, but the cultures were untyped.

Examination of the cultures from a small proportion of the remaining 35 turkeys revealed the presence of a number of yeast cells, but bacterial contamination was so great in these cases that it was impossible to obtain a pure culture of the yeast.

Sixty-three fowls were examined, of which 35 showed lesions in the crop. *C. albicans* was isolated from nine of them, all of which had shown lesions of mycosis. In two mycosis was diagnosed, but the remaining seven were "undiagnosed" or "debilitated." Yeasts, other than *C. albicans,* were obtained from 10 other fowls, and from one young chicken a species of Geotrichum was isolated. Cultures from the remaining 43 fowls were negative, or else examination only revealed the presence of individual yeast cells.

Lesions

The crop lesion in the majority of the young turkeys was similar to that already described in Part I. In the older turkeys, and in most of the fowls, the lesions were diffuse and spread evenly over most of the crop surface, the thickened mucous membrane, in many cases, forming folds. The lesion in the crop of fowls was dirty grey in colour, but was less pitted than that in young turkeys and resembled a piece of rough velvet rather than turkish towelling; the desquamated epithelium was more closely adherent to the underlying tissue and was not easily displaced by water under pressure, as in the case of the lesion in turkey poults. In the fowl there was a greater tendency for the lesions to extend into the upper and lower œsophagus, and in some fowls it was difficult, without the aid of histological examination, to differentiate the mycotic lesion in the œsophagus from that sometimes associated with nutritional roup (avitaminosis—A). As in turkeys, branching hyphæ were clearly visible in stained sections of crop and œsophagus (see Part I). In one fowl, which showed extensive crop and œsophageal lesions, histological examination of proventriculus, gizzard, duodenum, liver and kidney was made. Evidence of the spread of the fungus was demonstrated only in the liver, in which there was extensive local necrosis with a few hyphæ at the centre of the damaged area.

Technique of Examination

Direct smears of scrapings from the lining of the crops, mounted in lactophenol, and warmed slightly, were examined under the $\frac{1}{6}$" objective. It

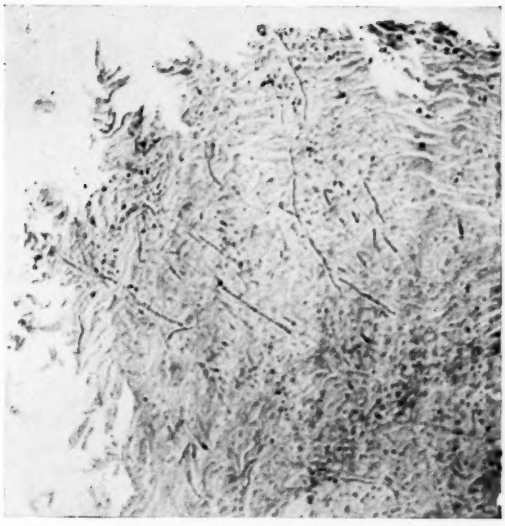

PLATE I.—Section of the crop of a turkey poult showing proliferation of the epithelium and hyphæ of *Candida albicans*. Stained hæmatoxylin and eosin x 160.

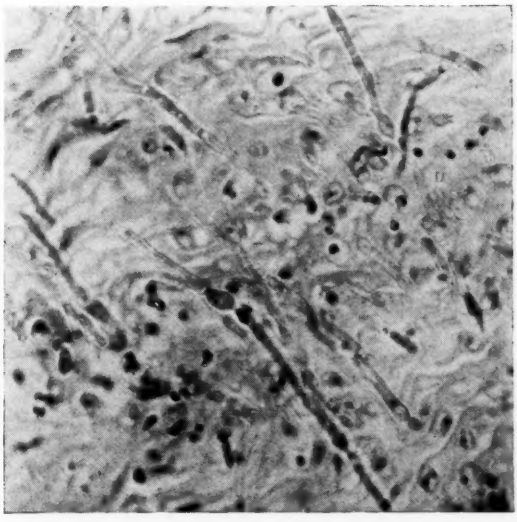

PLATE II.—Portion of the same section x 650.

(*Article by Blaxland and Fincham, page* 221)

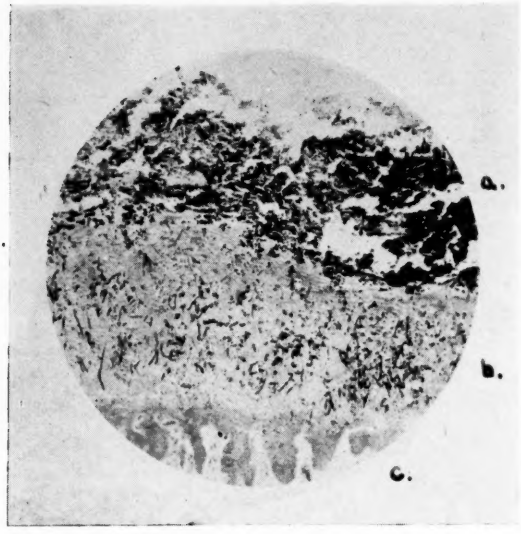

PLATE III.—Section of the crop of a turkey poult showing:—
(a) Surface layer with epithelial debris containing large numbers of yeast spores of *C. albicans*.
(b) Middle layer or *stratum corneum* showing spores and hyphæ, the latter predominating in the depth of the tissue.
(c) Deep layer or normal *rete mucosum* resting on the subepithelial connective tissue. Stained by the Gram-Claudius method x 70.

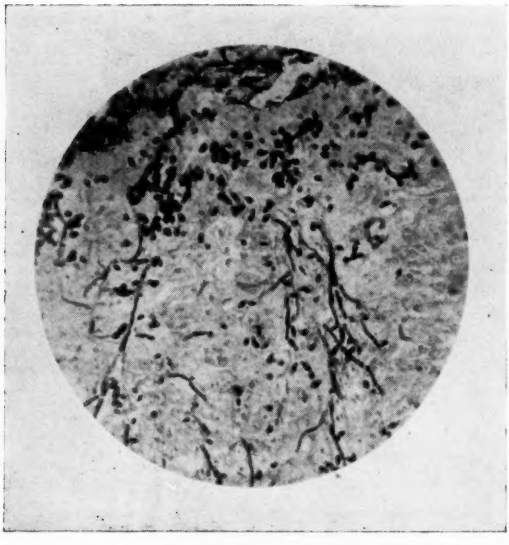

PLATE IV.—*Stratum corneum* of the same section showing yeast spores and hyphæ x 300.

(*Article by Blaxland and Fincham, page* 221)

PLATE V.—Acute lesions of moniliasis in the crops of turkey poults.

PLATE VI.—Chronic diphtheritic lesions (turkish-towelling) in the crop of six-week-old poult.

(*Article by Blaxland and Fincham, page* 221)

PLATE VII.—A group of four- to five-week-old poults suffering from moniliasis. *Note* lesions of dermatitis on the feet of the poult immediately to the left of the near end of the food trough, and on the foot of poult next but one above it on the same side of the trough.

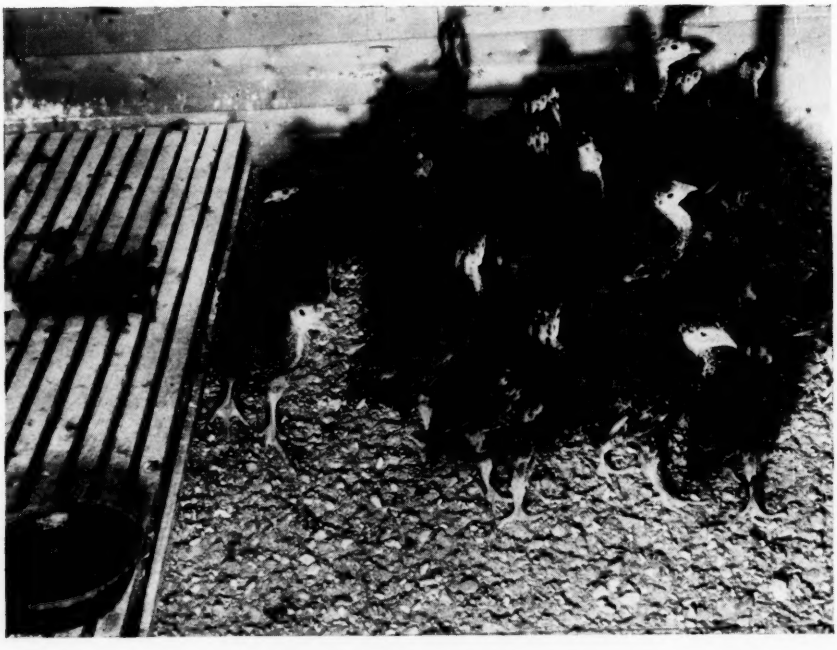

PLATE VIII.—A similar group of six- to seven-week-old poults.

(*Article by Blaxland and Fincham, page* 221)

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was not always easy to differentiate mycelial threads and spores of the organism from other debris, but their demonstration in deep scrapings prepared from the washed lining of a crop showing typical lesions was considered sufficient to warrant a positive diagnosis of clinical mycosis. A yeast growth was obtained on culture from most of the specimens giving a positive direct smear, but growths were also obtained from a number of specimens where the examination of direct smears had been negative or inconclusive.

Primary cultures were made on 2.5 per cent malt extract agar or on Sabouraud's agar plates, care being taken to spread the inoculum in order to facilitate isolation of colonies for further investigation. Incubation overnight at 37 degrees C. invariably produced an initial growth which spread gradually on plates at room temperature; the colonies gave off a characteristic yeasty odour. Smears of the growths after 24 hours' incubation were prepared by emulsification of a needle point of culture into a drop of 10 per cent Nigrosin on a slide and examined under the 1/12th" oil immersion lens; the various yeast forms stood out clearly against the dark background and were easily distinguished from bacterial contaminants. This examination was a more simple process than staining by Gram's method and resulted in less distortion of the individual yeast cells. Gram's method, however, was used as a routine on all the earlier examinations and where there was heavy bacterial contamination it was sometimes preferable to the use of Nigrosin, as the Gram reaction of the bacteria could also be noted.

Characteristics of Candida Albicans Isolated from the Crops of Turkeys and Fowls

The tentative typing of the cultures isolated in this survey was based on the information already provided by Jungherr (1933 and 1934). He had obtained two species of the Candida genus from his specimens: *C. albicans* and *C. krusei* and also an *Oidium* (now known as *Geotrichum*) species; he considered *C. albicans* and probably also the *Oidium* species, to be pathogenic to chicks and poults, but not *C. krusei*. *C. albicans* has long been recognised as the cause of " Thrush " in children and, experimentally, most strains have proved to be pathogenic to rabbits.

It was therefore assumed that most of the cultures isolated in this survey would also fall into the same three groups. Three distinct types of yeasts were obtained, but some of the earlier cultures although tentatively typed as *C. krusei* were not confirmed as such by Dr. Ainsworth.* The typing of *Candida albicans* was based on growth characteristics, morphology of the yeast cells, and on carbohydrate fermentation reactions. These features were found to be satisfactory for routine purposes, and on every occasion (seven in all) when strains

* Since this article was sent for publication a further six months' work has been completed on the identification of yeasts isolated from poultry. Dr. Ainsworth has confirmed that several cultures isolated from the crops of fowls were typical *Candida krusei*. Other yeasts, similar to those included under the heading *C. krusei*-like species in Table II, closely resemble that organism but further investigation has shown that they do not produce a mycelium and should not, therefore, be included in the *Candida* group at all. The identification of this other yeast has not yet been completed.

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typed of this basis, were sent to him, Dr. Ainsworth was able to confirm that they were *C. albicans*.

The inoculation of rabbits was only used as a confirmatory test. 1 cc. of saline emulsion of a 24 hour culture of *C. albicans* grown on solid media and standardised to No. 5 Brown's scale opacity tube, when inoculated intravenously, caused death in from two to four days. The characteristic abscesses occurring in the kidney and other organs, literally teeming with budding yeasts, were described with illustrations by Benham (1931). Representative cultures from the *Krusei-like* group were also tested in the same way but none of them proved to be pathogenic for rabbits.

In addition to the *Candida group* and the single *Geotrichum species*, a number of other fungi were encountered, most of them *Aspergillus species*. They were easily distinguished on culture from the yeasts by their typical mould growth, fluffy in appearance with aerial hyphæ, whereas the yeast growths, with their dense compact colonies, most closely resembled bacteria.

The chief characteristics of *Candida albicans* compared with those of the *Krusei-like* group, are listed together with those of the Geotrichum species in Table II.

TABLE II.

The Chief Characteristics of Candida albicans compared with those of other yeasts isolated from turkeys and fowls.

	C. albicans	*C. krusei-like species*	*Geotrichum species*
Appearance of colonial growth on solid media after 24-48 hours' incubation at 37 degs. C.	White, creamy convex colonies tending to pile up long line of original growth.	Low convex, yellowish colonies with a greater tendency to coalesce and spread over the surface of the medium.	Spreading growth without much colonial formation; rather adherent and not easily emulsified. Older cultures became wrinkled, corrugated and yellowish in colour.
Shape of yeast cells.	Large oval-round cells, with evidence of budding.	Elongated cells, with pointed ends and often with small terminal buds.	Oval cells, but often three or four of them joined into short chains, flattened at points of contact with one another.
Carbohydrate fermentation reactions.	Produces acid and gas in glucose, lævulose and maltose; some strains did not produce gas. Slight acid in galactose and sucrose. No change in lactose and raffinose as a rule; occasional strains produced acid but no gas.	Produces acid and gas in glucose and lævulose but not in maltose. No change in maltose, galactose, sucrose, lactose, and raffinose.	No fermentation in carbohydrates.
Pathogenicity.	Pathogenic to rabbits.	Non-pathogenic.	Non-pathogenic.

Carbohydrate Reactions

In the initial stages of this investigation ordinary routine bacteriological media were used with 1 per cent carbohydrate, but subsequently 3 per cent was used. Growth and fermentation reactions were more consistent with this concentration than with 1 per cent carbohydrate.

It should be emphasised that the techniques and methods described in this paper are only presented as a rough guide to the study of yeasts isolated from poultry. It is hoped that this description will be of value to other workers meeting this problem for the first time. The typing of yeasts is an extremely specialised subject and anyone attempting to do so is strongly advised to obtain confirmation of their opinion from an experienced mycologist.

Discussion

It is always difficult to assess the significance of bacteriological and cultural findings when disease cannot be attributed to a single organism. When an organism, thought to be pathogenic, is also found occurring naturally in other birds or animals without causing disease, it is impossible to say whether an increase in the virulence of that organism, or a lowered resistance of the hosts owing to environment factors, or to some other concurrent infection, is the primary cause of the disease. The data provided in this paper suggest that *C. albicans* is frequently present in the crops and digestive tracts of debilitated poultry and a more extensive survey may prove it to be a normal inhabitant of the crop of healthy birds. On the other hand, the course of the disease in the five outbreaks reported in this paper definitely suggested that the organism spread rapidly through the affected groups of poults and was ultimately a primary pathogen. On one farm in particular (Farm C), infection in the brooder house became so widespread that exposure for only 24 hours was sufficient to establish disease in a group of poults prior to their removal by a purchaser; furthermore, infection on this farm had already proved resistant to the farmers' routine disinfection and it persisted in the infected building throughout the rearing season.

The history of the outbreaks on Farms B and C did not suggest that the organism was carried on the eggs set in the incubators, as was suggested by Jungherr (1933); several thousand poults were reared without loss when supplied to customers direct from the incubators, although others from the same hatches died after a few weeks in the infected brooders.

On one of the five farms only was the diet of the affected poults obviously unsatisfactory by normal standards, but on two of the remaining four farms, general management and bad hygiene could also have been environmental factors that might have caused loss of resistance to the disease. Details of management were incomplete in one outbreak and, therefore, it can only be claimed that on one of the five farms there were no environmental factors that might have produced debility in the affected poults.

An interesting speculation follows the observation that many poults in the affected groups on all five farms showed evidence of vitamin B deficiency. It is

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particularly interesting that, on the farm on which management and feeding were considered to be satisfactory, a tentative diagnosis was actually given of dietetic dermatitis before moniliasis was confirmed and before further enquiry had revealed that it was highly improbable that the diet fed to these poults could have been deficient in vitamin B. The possibility arises, therefore, that *Candida albicans* in the crop may utilise vitamin B in the food or prevent its absorption by the bird, thus creating a state of a-vitaminosis in the affected poult. Fearson (1947) in his textbook refers to certain water-soluble factors known as bios, which are necessary for the growth of monocellular organisms and he gives pantothenic acid, in particular, as being necessary for yeast growth; other bios substances are nicotinic acid, vitamin B, biotin and folic acid, all of which are often grouped under the general heading of vitamin B complex and are present in the same natural foods.

The isolation of *Salm. typhi-murium* from poults on three of the five farms is interesting but it should be emphasised that only individual specimens were affected from each group examined and, although possibly of significance in the individuals concerned, it is not considered that the salmonella infection was of any real importance in these outbreaks.

The evidence presented in this paper in general justifies the conclusion already arrived at by Hinshaw (1934), that moniliasis in turkeys is likely to be associated with unhygienic surroundings and is probably secondary to other debilitating conditions. It would also appear, however that the causal organism may be commonly present in most domestic poultry and when given a suitable environment, it may multiply rapidly with considerable increase in its virulence, thus becoming a primary pathogen to turkey poults and young chickens.

Summary

(i) Five outbreaks of moniliasis are reported in which serious mortality occurred among young turkeys. *Candida albicans* was isolated from dead turkeys on all five farms.

The symptoms, post-mortem findings and diagnosis of the disease are described.

The history and course of the disease in four of the outbreaks tended to confirm the opinion of other workers that moniliasis does not occur solely from the presence of *C. albicans* in the crop, but as a result of combination with other environmental factors.

(ii) A preliminary survey of specimens sent for routine post-mortem examination was carried out. 55 turkeys and 63 fowls were examined. *C. albicans* was isolated from 14 turkeys and 9 fowls, all of which had been suffering from some other pathological condition.

A method of isolation and preliminary typing of *C. albicans* is described.

Acknowledgments

We wish to express our thanks to Dr. G. C. Ainsworth of University College of the South West, Exeter, for his kindness in typing so many of these cultures,

and also to Dr. R. W. Riddell of the London School of Hygiene for his help and advice on the mycological aspect of the work.

We are also indebted to Messrs. T. P. Duffy, C. J. N. Godfrey and C. Crompton, veterinary officers of the field staff of the Animal Health Division, Ministry of Agriculture, for their assistance in investigating these outbreaks.

The photographs of affected turkeys and specimens were obtained by Mr. Duffy with the assistance of a professional photographer. Thanks are also due to Mr. A. Norman, Chief Technician at the Veterinary Laboratory, for the photomicrographs. The preparation of the sections was carried out by the staff of the Pathology Department under the guidance of Mr. L. M. Markson.

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GROWTH OF SKELETON OF THE FŒTAL SHEEP

By D. BENZIE,

The Rowett Research Institute, Bucksburn, Aberdeenshire.

THE accurate early diagnosis of pregnancy in ewes is at present only possible radiologically; yet to obtain an estimate of the age of the fœtus or fœtuses when there is no exact information about the date of tupping, some knowledge of the development of the fœtal skeleton in relation to age is essential. The present work was undertaken as a complementary study to an investigation on the radiological diagnosis of pregnancy in ewes and its results are recorded in this paper.

The fœtuses studied were obtained from Scottish Blackface ewes previously maintained on fairly good quality lowland pasture without supplementary feeding. The fœtuses were delivered by cæsarean operation from the 49th day of gestation onwards at intervals of 5 to 11 days until full term was reached, and radiographs were taken after they had been used for other experimental studies.

The exact tupping date of each ewe was ascertained: the fœtuses of any ewes served twice are not included in these observations.

A search of the literature did not reveal any published radiographs of the skeleton of the fœtal sheep beyond the observations of Curson and Quinlan (1936) who have published radiographs of the fœtus as it appears living in the uterus of the ewe. The present study gives clearer definition.

Technique

All fœtuses were radiographed in the lateral position, with the exception of the fœtus of 81 days, which was radiographed dorso-ventral (Figs. 5 and 13).

The X-ray penetration was kept constant for each radiograph, so that the degree of ossification and of bone density in fœtuses of different ages can be compared. The radiological rating used was 50 M.A. at 55 K.V. with an exposure of 0.8 sec. No intensifying screens were used and the tube distance was five feet. The film casette was in contact with the fœtus, so that magnification of the fœtus was negligible. The reproductions in this paper from Fig. 5 onwards have in most cases been reduced in size.

The growth of bone can be measured between different fœtal ages from the radiographs obtained. The radiographs of the fœtuses show the development of the fœtal skeleton and illustrate the features described in the text.

Barium sulphate in suspension was administered by mouth to the fœtuses shown in Figs. 7, 8, 10 and 11. The shadow of the barium sulphate is clearly seen and should not be confused with bone.

The plate (Fig. 1) shows a fœtus at the 49th day of gestation. In the head there is some indication that the membranous nuclear ossification has begun, although there is no delineation of the various bones which contribute to form the cranium and face nor any trace of cartilaginous ossification of the jaw bones. Distinct nuclei of ossification are seen in the thoracic vertebræ and ribs, together with a faint suggestion of ossification in the diaphyses, or shaft, of the humerus and femur. At 54 days (Fig. 2) the advancement of the skeleton is most marked in the head. The membranous nuclear mass has begun to differentiate into the individual bones of the cranium, and there is cartilaginous ossification of the jaw bones. In the cervical vertebræ ossification is present and the wings of the atlas are defined; the ossified cartilage destined to form the lumbar vertebræ is present, and the nuclei of the diaphyses of the long bones are detectable.

At the 60th day the whole skeleton develops rapidly (Fig. 3), bone formation is evident in the shaft of the humerus, radius, metacarpus and first phalanx of the thoracic limb, and in the femur, tibia, and metatarsal bones of the pelvic limb.

At 70 days (Fig. 4) the main features of the whole skeleton are clearly seen although there is still no ossification of the sternum or the epiphyses of the long bones. In the head no visible formation of the bony contours of the occipital, parietal, or frontal bones, or of the petromastoid area of the temporal bone can be detected. The spinous processes of all the vertebræ are now visible, and the scapula, ulna, ilium and ischium are recognisable as separate entities.

New features are found in a fœtus of 81 days. From the radiograph (Fig. 5) taken in dorso-ventral position the new feature is the metacarpal bone which is clearly seen divided into two parts. This can be seen as early as 60 days, but at the time was not appreciated. The second and third phalanges are also visible at 81 days but there is still no trace of the nuclei of any of the epiphyses of the long bones. The transverse processes are seen in the thoracic vertebræ as well as the nuclei of two of the tarsal bones in each of the hind legs; the gap between the ilium and ischium appears smaller than at 70 days.

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In the 90-day fœtus the additional development is largely confined to the head, where the facial bones and the eye orbit are formed; in the remainder of the skeleton the chief feature is the ossification of the sternum. The vertebræ are now equally spaced and evenly developed and diminish regularly in size from the atlas to coccyx (Fig. 6).

During the interval between the 90th and 100th day, ossification increases rapidly in all parts of the skeleton and in the 100-day fœtus (Fig. 7) ossification is visible in the epiphyses of the humerus, femur, tibia and radius, while the gap between the ilium and ischium is greatly reduced.

At the 110th day (Fig. 8) the tooth sockets in the mandible are seen and incisor teeth are present: otherwise increase in length of bone in all parts of the skeleton, reduced intervertebral spaces, and development of the epiphyses of the long bones are the main features.

At the 120th day further advancement of the epiphyses of the long bones is evident, which, together with greater density of the cortex of the bones,

TABLE I

Summary of the chief radiological features in the development of the fœtal skeleton of the sheep

Gestation period (days)	Head	Vertebral column	Ribs and sternum	Thoracic limb	Pelvic limb
49 (Fig. 1)	Head (1)	Thoracic vertebræ (2)	Ribs (2)	Humerus (2)	Femur (2)
54 (Fig. 2)	3 bones of cranium mandible (2)	Cervical and lumbar vert. (2)	Ribs (3)		
60 (Fig. 3)		Body of vertebræ (3)		Humerus, radius, metacarpus (3)	Femur, tibia, metatarsal (3)
70 (Fig. 4)		Spinous process thoracic and lumbar vertebræ (3)	Ribs (5)	Scapula, ulna (3)	Ilium, ischium (3)
81 (Fig. 5)	Cranium and mandible (5)	Transverse processes thoracic vertebræ (3)		Humerus, radius, metacarpus (5)	Ilium, ischium (4)
90 (Fig. 6)	Facial bones and eye orbit (3)		Sternum (3)		
100 (Fig. 7)				Humerus, radius, metacarpus (6)	Femur, tibia (6)
110 (Fig. 8)	Tooth sockets, incisor teeth formed	Vertebral column (5)		Humerus, radius, metacarpus (7)	Femur, tibia, metatarsal (7)
120 (Fig. 9)	Whole head (8)	Vertebral column (8)	Ribs and sternum (8)	All bones (8)	All bones (8)
140 (Fig. 10)				Long bones (9)	Long bones (9)

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indicates greater strength (Fig. 9). There is a fibrous appearance in the nasal bones not shown in Fig. 9 which can be detected in the head.

Between the 120th and 140th day the progress in growth is chiefly confined to the epiphyses of the long bones, which at 140 days (Fig. 10) are on the point of fusion with the shafts. The intervertebral spaces close still further, but there does not appear to be any fusion of the ribs with the sternum after the fifth rib as no costo-chondral prolongations are visible.

Fig. 11 shows the new-born lamb. It is clear that fusion of the epiphyses with their diaphyses is not complete, but that all bones are close to their mature formation. The articulating surfaces are developed and the joint spaces are closed so that the extra-articulating cartilages are able to function without danger of displacement.

In the reproduction of the radiographs some features mentioned in the description are not readily seen. In order to clarify some points in the plates not visible in the lateral position, additional plates of the particular points mentioned are included. Fig. 12 shows the spinous processes of the vertebræ described at 70 days, and Fig. 13 is a section of the radiograph showing the metacarpus divided into two bones and the transverse processes of the thoracic vertebræ as described at 81 days.

The principal radiological features of the development of the skeleton of the sheep fœtus are collected in the table (page 233).

The key to the numbers given in the table are as follows:—

(1) Membranous ossification.
(2) Cartilaginous ossification.
(3) Bone ossification.
(4) Closing of bone space.
(5) Bone density (increase of bone ossification).
(6) Cartilaginous ossification of epiphyses.
(7) Bone ossification of epiphyses.
(8) Increased bone density.
(9) Point of fusion of epiphyses with diaphyses.

Summary

Radiographs are presented showing stages in the development of the skeleton of the fœtal lamb from the 49th day until full term.

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FIG. 1.—49-day fœtus. Membranous mass of cranium. Some ossification of the thoracic vertebræ and ribs. (Positive print. Natural size.)

FIG. 2.—54 days. Advancement in the bone formation of the cranium, with additional cartilaginous ossification of the vertebral column. (Positive print. Natural size.)

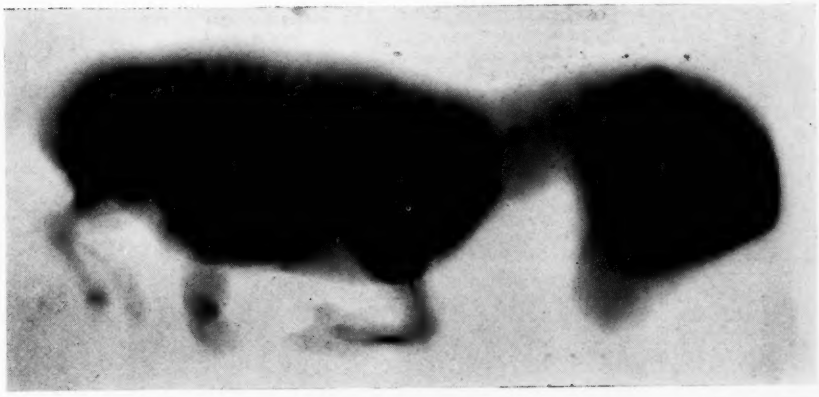

FIG. 3.—60 days. Advancement of the ossification of the long bones. (Positive print. Natural size.)

(*Article by Benzie, page* 231)

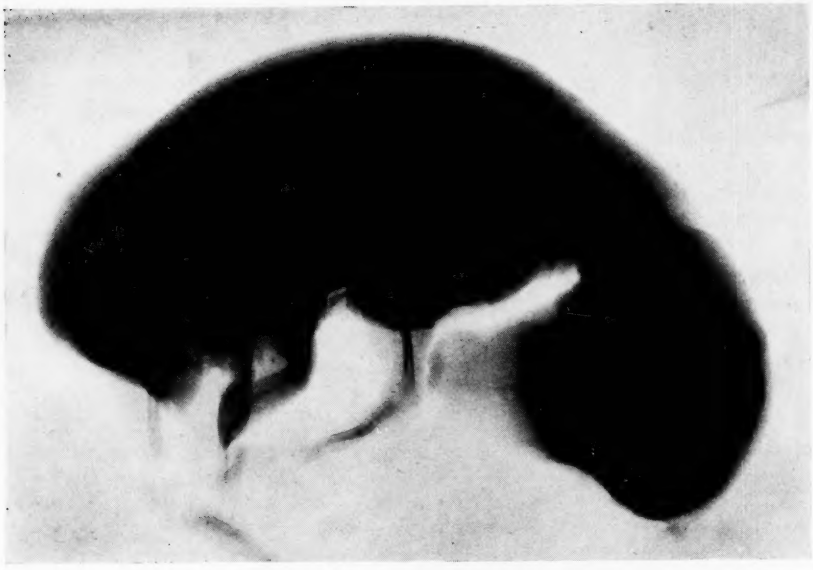

FIG. 4.—70 days. Rapid development of the skeleton in general. (Positive print. Natural size.)

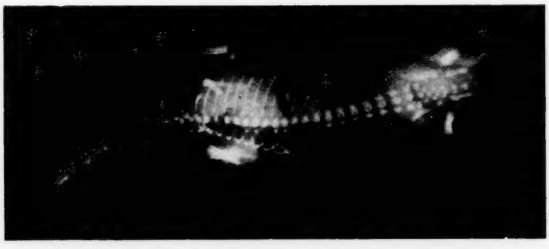

FIG. 5.—80 days. Main feature: the right metacarpus seen as two bones. (Print of negative. Approx. ⅓ natural size.)

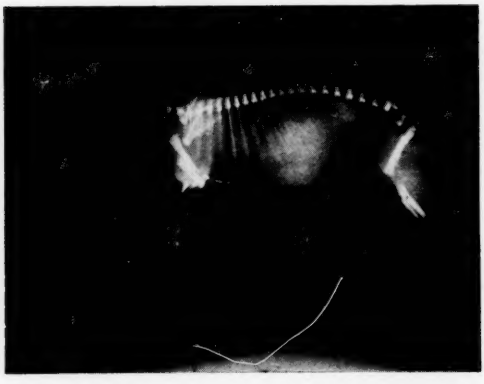

FIG. 6.—90 days. Development of the facial bones and ossification of the sternum. (Print of negative. Approx. ⅓ natural size.)

(*Article by Benzie, page* 231)

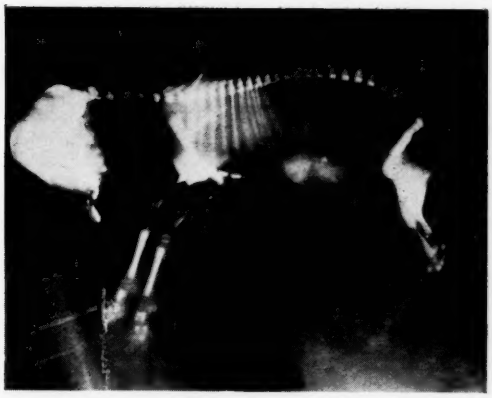

FIG. 7.—100 days. Epiphyseal nuclei of the long bones: those of radius and tibia are clearly seen. Shortening of the gap between ilium and ischium. (Print of negative. Approx. $\frac{1}{4}$ natural size.) Shading of lower half of negative is to bring out structure of rest of body.

FIG. 8.—110 days. Hardening of the cortex of all bones. (Print of negative. Approx. 1/5th natural size.)

FIG. 9.—120 days. Progress of epiphyseal growth of the long bones. (Print of negative. Approx. 1/5th natural size.) Blurring due to animal's movement as taken whilst still alive.

(*Article by Benzie, page* 231)

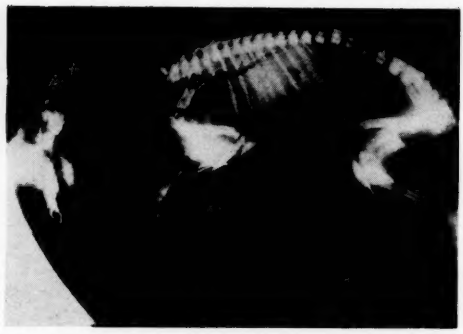

FIG. 10.—140 days. Closure of the intervertebral spaces and the epiphyses at point of fusion with the shafts of the long bones. (Print of negative. Approx. 1/6th natural size.)

FIG. 11.—147 days. New-born lamb. All bones close to mature formation. Articulating surfaces developed but diaphyses and epiphyses not fused. (Print of negative. Approx. 1/6th natural size.)

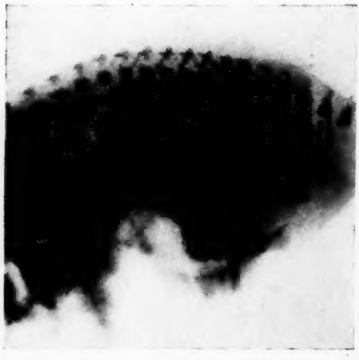

FIG. 12.—Selected section of 70-day fœtus to show spinous processes of thoracic vertebræ. (Natural size.)

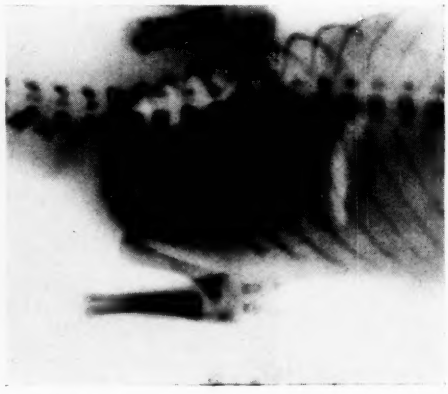

FIG. 13.—Selected section of 81-day fœtus to show divided metacarpus and transverse processes of cervical and thoracic vertebræ. (Natural size.)

(*Article by Benzie, page* 231)

SEDIMENTATION RATE IN SHEEP

By HUSSIEN REDA, M.V.Sc.(Cairo),

Lecturer in Veterinary Department, Fouad I University, Faculty of Agriculture.

SEDIMENTATION rate or suspension stability of blood is an important test in physiology, clinical pathology and gynæcology, as well as an aid to diagnosis and prognosis.

The sedimentation test is non-specific, but to the clinician it is of value as an index to the progress, activity or resolution of an infection. It gives a guide as to the course of disease, the efficacy of treatment, the convalescent period, and optimum time for operation. It is also a useful aid in following the course of certain pathological conditions of man, especially tuberculosis.

Literature

The suspension stability of erythrocytes in blood was first observed in the second century by Galen[1] with the formation of "crusta phlogisticæ." Hewson[2] (1771) and Hunter[2] (1794) noticed rapid settling of corpuscles and attributed it to inflammation. Hunter[3] (1797) found that the sedimentation rate of R.B.Cs. varied according to the severity of infection. Fahraues[4] (1918) used the test in the diagnosis of pregnancy in women.

The results secured by many workers indicate that sedimentation rate increases proportionally with the amount of tissue destruction. In acute infectious diseases, carcinoma, severe local infection, tuberculosis, and other diseases, the rate of sedimentation closely parallels the amount of tissue destruction.

Loebner[5] (1918) reported that sedimentation rate increased in cancer. Schurer and Eimer[6] (1921), Hasselhorst[7] (1922) stated that sedimentation rate is increased in infectious diseases and surgical inflammation.

Polak and Mazzola[8] (1924) gave graphic representations of their findings as to the relative values of sedimentation rate and leucocytic count and temperature in groups of cases. Bochner and Wassing[9] (1925) declared that sedimentation rate is more sensitive and indicative than leucocytic count and temperature. Knowles[10] (1949) stated that an increase in the fibrinogen and globulin fractions of plasma protein is responsible for the clumping of cells and their consequently more rapid rate of sedimentation.

Material and Method

In the present investigations the animals used were sheep of varying ages from half a month to five years, and of both sexes. These sheep were among the herd of the Faculty of Agriculture, Giza, Egypt, belonging to both Breeding and Feeding Sections. Most of the work was carried out on healthy sheep; few diseased cases were investigated for their effect on the sedimentation rate.

Blood samples were taken from the jugular vein, usually at the upper third, after clipping the hair and disinfecting the area with tincture of iodine. The

syringe contained the proper amount of the anti-coagulant, which was sodium citrate 3.8 per cent. The amount used was 0.4 c.c. of this solution for every 2 c.c. of blood. The syringe was completely free from air, the needle was introduced into the vein, and 2 c.c. of blood was drawn gently. The needle was removed from the syringe, the tip was closed, and the syringe was shaken several times to ensure thorough mixing. The blood was then transferred to a watch class. The Westergren method[11] had been followed in this work. The blood was drawn up into a standard Westergren tube which was 2.5 mm. in diameter and graduated from above downwards from zero to 200 mm., the calibration being carried to the extreme point from which the blood was drawn up to the zero mark.

The tube was put upright in the special stand, in which a spring clip pressed on the top and held the point firmly against the rubber disc at the lower end. The tube was left to stand and the erythrocytes began to settle down, leaving a clear supernatant plasma. The upper level of the red cell column was usually sharp and distinct. The level of the R.B.Cs. column was read at the end of one, two and three hours,, because the sedimentation rate of sheep is very slow as compared with man and certain other mammals. The distance of sedimentation in mm. was recorded.

Results

Observations were made on the blood of 15 new-born lambs (up to 15 days of age) to determine the sedimentation rate, which was decreased in comparison with the average normal rate of adult sheep. It was about 1 mm./hr.

On examining 25 lambs, each of which was about one year old, the sedimentation rate increased gradually to 2 mm./hr.

On examining 20 sheep about two years of age, the sedimentation rate was fluctuating ,between 2 mm./hr. and 3 mm./hr., with an average normal rate of 2.5 mm./hr.

Sedimentation rate in 20 other sheep from three years to five years of age was 2 mm./hr.

The sedimentation rate in females among the eighty normal cases showed nearly the same rate as in the males.

Holman[12] stated that sedimentation rate in healthy sheep is 3 mm./hr.

These observations are in accord with the sedimentation rate findings in human being. It has been shown by Fahraues[13] that sedimentation rate is 0.5 mm./hr. in new-born children, 7 mm./hr. in children at two years, 6 mm./hr. at six years, 3 mm./hr. in adult men, and 7 mm./hr. in women.

Pickering[14] stated that the serum albumin in the blood of the new-born child is high in amount as compared with serum globulin or fibrinogen. These two proteins make their appearance during embryonic development much later

than albumin. Kennaway[15] attributed the decrease in sedimentation rate to this decrease of serum globulin and fibrinogen and an increase of albumin.

Another factor which is considered as a cause of decreased sedimentation rate in new-born lambs is the number of erythrocytes, which is higher in new-born animals than in adult life. Plant[16] mentioned that an increased number of red blood corpuscles increases friction and decreases sedimentation rate.

Twenty ewes of different ages were tested at different months of pregnancy, and the results obtained indicated that the sedimentation rate was somewhat increased, but the fluctuations were within the range of values recorded from non-pregnant ewes. Some pregnant ewes showed a slight rise in the sedimentation rate, but others were normal. The sedimentation rate varied between 0.2 mm./hr. and 0.6 mm./hr., with an average normal rate of 0.4 mm./hr. over the normal sedimentation rate of the non-pregnant ewes.

Gram[17] found an increased rate in pregnancy. Friedlander[18] stated that the blood sedimentation test applied on pregnant women yields no practical results from which it can be utilised as a test for the diagnosis of pregnancies before the fourth month. Mathieu, Trotman, Haskins, Osgood and Albert[19] stated that the sedimentation rate may be increased after the second month, but values still fall within normal limits. The increase is gradual to the latter months of pregnancy, and an occasional normal reading may be found at any time during pregnancy. Linzenmaieyer[20] and Maccabruni[21] found that the increase of sedimentation rate during pregnancy is due to the decreased capacity of the plasma to retain its corpuscles in a state of suspension. Starlinger and Samson[22] pointed out that increased sedimentation rate during pregnancy is in some cases due to an increase in the fibrinogen content of the plasma. Wohlisch and Bohner[23] maintained that increase of rate during pregnancy is due to the presence of fine, elastic threads of fibrinogen which adhere to the erythrocytes, causing larger clumps of rouleaux, which, in turn, cause rapid sedimentation rate.

Knowles[10] stated that sedimentation rate is 4 to 7 mm./hr. in adult females, and 35 mm./hr. in pregnancy.

Fifteen sheep were tested early in the morning during the winter and on extremely cold days. The test was carried out in a closed room at atmospheric temperature, and it was found that sedimentation rate was decreased by about 0.5 mm./hr. below the normal rate.

Barf[24] also found that sedimentation rate is lower in cold weather.

Ten ewes were tested after delivery, and showed a very slight decrease in a few cases, but we cannot give a definite decision on this finding.

Mathieu and others[25] stated that sedimentation rate drops rapidly five days after parturition, reaching normal values at the end of the second month.

The sedimentation rate is now recognised as an important clinical aid in following the course of certain pathological conditions of man, especially tuberculosis.

The results secured by many workers indicate that the sedimentation rate increases proportionally with the amount of tissue destruction. In acute infectious diseases, the sedimentation rate closely parallels the amount of tissue destruction.

Some diseases showed no appreciable variation from the normal, while others showed a definite change.

Among the diseases which showed practically no change in the sedimentation rate and gave negative response was mange.

Six sheep about two years of age, affected with mange were tested. They gave an average sedimentation rate of 2.3 mm./hr. They were tested again after recovery, and gave a sedimentation rate of 2.6 mm./hr. They showed practically no evidence of change in the sedimentation rate.

Among the diseases which gave an accelerated sedimentation rate was mastitis. Sedimentation rate was determined in four sheep affected with mastitis. The rate was increased before treatment, and decreased, reaching normal rate after treatment.

Two infected sheep, each of which was about two years old gave a rate of 3 mm./hr. and 4 mm./hr. On recovery, the rate in both decreased, reaching the normal rate of 2.5 mm./hr. The other two infected sheep each about three years of age, gave a rate of 2.5 mm./hr., and, on recovery, gave a normal rate of 2 mm./hr.

Ferguson and Madison[26] discussed this in cases of mastitis in calves. They found, in chronic cases, that there may be a rate which is slightly above normal. They also checked cases of acute mastitis, and found a marked increase in the rate.

Conclusions

1.—The sedimentation rate of sheep was found to be very slow as compared with other mammals.

2.—New-born lambs gave a sedimentation rate of 1 mm./hr.

3.—Lambs about one year of age gave a sedimentation rate of 2 mm./hr.

4.—Sheep about two years of age gave an average rate of 2.5 mm./hr.

5.—Sheep about three to five years of age gave a sedimentation of 2 mm./hr.

6.—Females showed almost the same rate as the males.

7.—Sedimentation rate cannot be utilised as a test for the diagnosis of pregnancy.

8.—Sedimentation rate was decreased by cold weather by an average of 0.5 mm./hr.

9.—In cases of mange, there was found to be a slight decrease in the rate of about 0.3 mm./hr.

10.—In cases of mastitis, there was found a marked increase of rate of about 1 mm./hr.

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CASE REPORT: A NOTE ON NEWCASTLE DISEASE

By PROFESSOR ZAKI MORCOS,

Cairo.

An outbreak occurred among fifteen fowls. They were about eighteen months old and laying. Four were Sussex, two were Wyandottes, one a Rhode Island Red, and the rest were Fayoumi, an Egyptian breed.

Two of the Fayoumi had been vaccinated against Newcastle disease six months before the outbreak. All the fowls, except the two vaccinated Fayoumi, died within five days.

The fowls were fed and watered at communal troughs. Adult Sudanese and Damietta ducks, some two-week-old Sudanese ducklings, various pigeons, and some young rabbits shared the same troughs. None of these contracted the disease naturally.

The symptoms observed in this outbreak were definite and characteristically diagnostic, i.e., respiratory, wheezing, etc., weakness of the legs, anorexia, and death.

In a previous outbreak, involving 35 fowls, I found that a vaccine prepared by passage into chick embryo was a most successful prophylactic, and in a few cases, when given in small repeated doses, it had a curative effect. It would appear that recovered or vaccinated birds act as carriers for possibly several weeks, as I was unable to trace the source of infection of the outbreak in question.

These two incidents caused me to test the curative effects of the virus in other outbreaks. In these outbreaks some of the affected birds were not treated with vaccine in order that they might act as controls.

Experiment (1)

Twenty-five chicks about six weeks old and all showing clinical signs of the disease and proved positive by laboratory test. Eleven were inoculated intra-muscularly with 1/10th of the normal dose for adult fowls. Fourteen were not vaccinated. Of the former, four recovered and seven died. All the fourteen unvaccinated birds died.

Experiment (2)

Twenty chicks aged one week. Ten inoculated intra-muscularly with 1/20th of the adult dose. Four recovered and six died. All ten unvaccinated birds died.

Experiment (3)

Fifty in contacts of the experiment (2) chicks were given 1/20th of the adult dose. Thirty-seven chicks recovered and thirteen died.

Experiment (4)

Seventy-seven chicks about one month old showing definite advanced

symptoms of Newcastle disease. They were inoculated with 1/20th of the adult dose. Twenty-three died, fifty-four recovered.

As a result of my experiences on the above natural outbreaks of Newcastle disease I am of the opinion that there is evidence that vaccination is a worthwhile curative method. Economically it is worth a more extensive trial, for approximately 50 per cent of affected birds recovered after vaccination whereas in the unvaccinated the death rate was 100 per cent.

The vaccine is prepared after attenuation by passage into chick embryo. The average dose for adult fowls is 1 c.c. of a 1/1000th suspension of dried chick embryo culture. My results appear to run contrary to the officially accepted views that:—

(a) Vaccination should not be carried out on infected flocks;

(b) Vaccination usually kills almost all infected birds.

Since Newcastle disease first made its appearance or was recognised in Egypt two or three years ago I have not encountered a case of fowl plague. I wonder if these two diseases are genetically interchangeable?

Finally, two points of economic importance. First, prophylactic vaccination should be carried out as early as possible before maturity for it interferes with laying for about two months.

Secondly, with really good nursing the percentage of recovery could be considerably increased. This applies to both vaccinated and unvaccinated birds. I have found that many chicks are lost through their being unable, owing to weakness, to reach the food and water troughs. In outbreaks where small numbers are involved a little hand-feeding, etc., would well repay the trouble involved.

REVIEWS

NOTES ON COMMUNICABLE DISEASES OF LABORATORY ANIMALS, by H. J. Parish. Edinburgh: E. & S. Livingstone, Ltd. Price 3s.

THIS is a timely publication, giving in concise form a wealth of information on the important subject of diseases of laboratory animals. More interest is now being taken in the health and maintenance of these animals. All laboratory workers appreciate fully the great necessity for healthy animals for experimental purposes and the disappointing and sometimes chaotic results which follow the use of badly nourished and disease-ridden guinea-pigs, mice, etc. Too much stress cannot be laid on the provision of healthy stock and the prevention and control of the infectious diseases which affect them. In this volume, the subject is dealt with in such a manner that the necessary information is readily available without much reading and is all that is required for a full appreciation of methods of control. We recommend this work to laboratory workers with every confidence that they will find it of great value.

ERRATA

" STUDIES on Equine Purpura Hæmorrhagica," by D. G. Harvey and R. H. Marchant, which appeared on page 162 in the April, 1950, issue of this journal.

Page 164, line 4 : for " since " read " and."

Page 165, line 2 : for " 33.7 " read " 3.7."

Page 167, line 16 : for " 65 mgms./100 ml." read " 6.5 mgms./100 ml."

NOTICE

PRICE reduction. The Distillers Company (Biochemicals), Ltd., Speke, Liverpool, announces a reduction, to take effect on July 3, in the price of the 300,000 i.u. vial of " Distaquaine " G brand procaine penicillin G for aqueous suspension, to 3s. 9d. per vial.

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